

PSYCHE.

A STUDY OF THE CATERPILLARS OF NORTH AMERICAN SWALLOWTAIL BUTTERFLIES.*—I.

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Interesting as are the transformations of a butterfly in the three earlier periods of its life, marked off by such strict lines from one another, the changes which the same insect undergoes in shape, in color and in clothing in the different stages of caterpillar life alone, are scarcely less surprising. This is true to so marked an extent in the caterpillars of our swallowtails that if in their earliest stages they were only large enough to have all their peculiarities readily seen by the naked eye, more attention would long ago have been given them. It is also important on other grounds. Weismann has mentioned the desirability of studying the early stages of these caterpillars in particular, to acquire a knowledge of their phylogeny, and they have formed the subject of an extended but still incomplete paper by Gruber,† somewhat barren in results from its incompleteness, and in some particulars from its inaccuracy. The more

complete material now at hand, studied almost entirely from fresh objects, the extraordinary variety among our New England forms, and the curious fact that these cover almost the entire range of variation known among the caterpillars of Papilionini the world over lend special interest to such an enquiry.

I propose in the first place to give for each of the six species of our fauna, each representing a distinct genus, as succinct an account as possible of the several important changes; next, to summarize from this the leading lines along which the changes have occurred; and finally to draw from the facts such conclusions as seem admissible.

The caterpillar of *Laertias philenor* (Fig. 1.) at birth is uniformly cylindrical, of a uniform dark brown, covered with several rows of conical warts of nearly uniform size, most of them bearing a single bristle, a few, on the thoracic segments and just above the abdominal legs, more than one. In its second stage the shape and coloring are the same as before, but the clothing of the body is greatly changed, for all the warts bearing single bristles have dis-

* Reproduced with slight changes from the author's *Butterflies of the Eastern United States and Canada*, pp. 1234-1241.

† *Jen. zeitschr. naturw.*, xvii; *Papilio*, iv.

appeared, together with their bristles, and so have the bristles of the other warts, but in these latter instances the warts remain, and have become short, fleshy, often brightly colored filaments; while to take the place of the simpler warts a new and independent series of fleshy filaments has arisen between the two series which disappeared. The remaining stages are much the same as this, only the filaments at the extremities of the body grow longer and longer with each stage, more and more highly colored; a suprastigmatal series of coral red spots is introduced in the fourth stage on some of the abdominal segments; and finally, in the last two stages, the thoracic segments taper forwards markedly.

The new-born *Iphiclides ajax* (Fig. 2) is cylindrical, but a little larger in front than behind, of a nearly uniform dark leaden color, darker, however, on the front half than behind, covered with rounded warts arranged in several rows, a few at the extremities slightly larger than the others, most of them supporting a number of bristles, generally widely forked at the tip. In the second stage every trace of tubercles and bristles, forked or simple, has gone, excepting a few slight, spineless warts at the extremities, and in their place fine, excessively short hairs are scattered over the body; this has become tumid on the thoracic segments, and is transversely striped with uniform black and white or yellowish bands, of which there are many to a segment. In the third stage the hairs are even less ob-

servable, and the stripes have become finer and tremulous, while the incisure between the last thoracic and first abdominal segment is marked by a broad, black, velvety stripe, edged in front with white and behind with yellow. The fourth stage shows no special change. In the fifth the broad, velvety stripe becomes more conspicuous, because the ordinary stripes become more or less obsolete; and when full grown the latter often or generally persist only as transverse series of black dots on a nearly uniform green body, though the yellow stripes remain, at least on the sides.

In *Jàsoniades glaucus* (Fig. 3) the infant caterpillar is cylindrical, slightly tumid anteriorly, of a dark brown or sometimes even velvety black color, a little paler beneath, the extremities lighter, and an oblique stripe in the middle above on each side, forming a sort of saddle-shaped whitish mark; the body is covered with several series of wart like tubercles, larger at the extremities than in the middle of the body, beset with bristles. In the second stage tubercles and bristles are gone, excepting at the extremities of the body, where they are relatively much reduced; the color and markings remain much as before, but are perhaps more diversified, and have added to them on the sides of many of the segments next the tubercles a minute bluish spot, that of the third thoracic segment (now more distinctly tumid) with a velvety black streak below it. In the third stage all the markings are still more distinct and

diversified, and the tubercles have almost entirely disappeared and been replaced by smooth, shining lenticles, while on the sides of the third thoracic segment the black spot and black streak have developed to a black annulus with a blue center. In the fourth stage the general color becomes at first a dark brownish olivaceous, with the same striking contrasts as before, but during the course of this stage this is replaced by a grayish green, and the saddle, which has been becoming yellow, fades and diminishes until a mere ghost remains; the first abdominal segment is edged behind with yellow, the lenticles have turned to colored spots, and on the third thoracic segment is seen at first a pair of roseate spots faintly edged with black, and a black line between them, afterwards becoming a single yellow spot, including below a luteous lenticle, above a velvety black streak, and in the middle a black-rimmed, turquoise spot. In the final stage the caterpillar becomes pure green above, pale bluish green below, and the only markings are a bright, transverse stripe of black and yellow at the hind edge of the first abdominal segment, a few rows of minute dark turquoise spots, and on the sides of the third thoracic segment a still further development of the markings, the whole now forming a rounded, quadrangular, greenish yellow spot, rimmed delicately with black, crossed above by a black bar, and enclosing below a black annulus with a turquoise centre.

In *Euphoades troilus* (Fig. 4) we

start in practically the same way as in *Jasoniades*, only the saddle is less oblique. In the second stage the caterpillar is plumbeous, with the lateral flaps of the pale saddle more distinct than the seat, the body paler below than above, and there is added a curving white streak below the middle of the sides of the thoracic segments, seeming to define better the tumid front portion of the body; bluish dots appear along the dorsal part of the segments, and on the third thoracic segment one at the side is velvety black, edged above and below with yellow; the tubercles are only distinct at the extremities of the body. The third stage hardly differs from the second, but the spot on the third thoracic segment is now larger and wholly rimmed with yellow. The fourth stage also closely resembles the preceding, but the tubercles are replaced by lenticles, one on the third thoracic segment black and glistening, and included in the black spot. The last stage is wholly different, the general color being a pure green, on which only the minor spots remain as links to the past, and reinforced by others which replace the lenticles; the spot of the third thoracic segment has altered: it is now a finely black-rimmed, large, orange and yellow spot, including a quadrate black nucleus below the middle, nearly half as large as the whole spot, and including within it posteriorly a shining black, blue-edged lenticle; a thin black line runs between this nucleus and the outer black rim in front; but an additional spot appears

on each side above on the first abdominal segment, a large, finely black-rimmed, rounded, orange spot seated at the posterior incisure on a fine black line which enlarges where the spot touches it; the two series of small abdominal spots have become distinctly turquoise.

In *Heraclides cresphontes* (Fig. 5) the young larva is provided with exceptionally large tubercles, which are largest at the two extremities, and especially on the first thoracic segment, and these are all thickly beset with bristles; the body is largest in front but scarcely tumid; the colors are very dark brown, more or less mottled, with a distinct white saddle and lighter extremities. Excepting that the front portion of the body is a little tumid, and that the tubercles become relatively less important, there is no change in the next two stages. In the fourth stage the front part of the body becomes distinctly tumid and at the same time develops an irregular, white, curving lateral band, setting off the tumidity to better advantage; the colors and patterns are otherwise the same as before, but the tubercles have become lenticles, and around them have clustered rings of brighter color, by which the body is much mottled. No further change is made in the final stage excepting that the colors are more varied, the whites have become more of a cream color, and the mottling is more noticeable, partly from the larger size; in

general the disposition of the markings is much as in the newly born caterpillar.

In *Papilio astyanax* (Fig. 6), finally, we have at birth a jet black caterpillar with a white saddle across the middle, and occasionally a white fleck or two in front of it; the body is cylindrical or nearly so, but the thorax shows a slight tumidity; it is tuberculate, with conical tubercles, beset with bristles; there is little inequality in the length of the tubercles, but those on the side of the body are dull orange. In the second and third stages we have a repetition of the same features in color, form and tubercles; the orange, however, becomes a little more vivid. In the fourth stage, too, the dark tubercles still remain but are relatively less important, and have at their anterior base a yellow or orange spot; while in the place of the orange tubercles are orange lenticles, and these and the other orange spots break what would otherwise be a broad, black, transverse band in the middle of each segment; for now the body has become green and is transversely striped with black in the middle and (more narrowly) at the front edge of each segment, and no sign whatever of the saddle remains; the form at the same time becomes more completely cylindrical, but the body tapers in front. In the last stage this general style of ornamentation and of form is kept, but the tubercles and lenticles altogether disappear.